þÿ P a n a m a r e n k o s N o m a d S c i e n c e

Sjöberg, Sami

de Gruyter
2018

þÿ S j ö b e r g , S 2 0 1 8 , P a n a m a r e n k o s N o m a d S c i e n c e . i n H V e i v o , J - P M Ayers , B Hjartarson & S Bru (eds) , Beyond Given Knowledge : Investigation, Quest and Exploration in Modernism and the Avant-Gardes . European Avant-Garde and Modernism Studies , no. 5 , de Gruyter , pp. 129-144 . https://doi.org/10.1515/9783110569230-010

http://hdl.handle.net/10138/311866
https://doi.org/10.1515/9783110569230-010

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acceptedVersion

Panamarenko's Nomad Science

Sami Sjöberg, University of Helsinki

The Belgian visual artist and sculptor Panamarenko (Henri Van Herwegen, born 5 February 1940) is best known for his massive aeronautical machines and technological sculptures. However, scholars have so far overlooked his theoretical output, which embodies many characteristics of the avant-garde. For instance, Panamarenko's "Closed system theory", dating from the 1960s and ranging through his later career, is an exercise in experimental physics. Applying this theory on a cosmological level, Panamarenko's *Toy Model of Space* (1993) is an instance where anti-Newtonian mechanics are applied to the movements of celestial bodies. Clearly, Panamarenko's approach to science and his use of the scientific method are idiosyncratic from a strictly scientific point of view.

Panamarenko was first and foremost interested in what could be, by extension, called counter-engineering, which sets out with a completed construction and only then investigates *why* that construction fails to function if made to work in an alternative or illogical manner. Overall, rather than following the hypothetical-deductive method of science, Panamarenko focuses on the immediate experience generated by the investigation of various anomalies and the praxis of their non-functionality, even though

that may sound counter-intuitive.[1] This essay addresses Panamarenko's alternative scientific method, which delves beyond the mere artistic appropriations of science and ranges into a liminal space where art and science converge. Panamarenko's theories exemplify what Gilles Deleuze and Félix Guattari have called *nomad science* by focusing on the specific, resistant and creative ways with which the relationship between the individual scientist-artist and the object of study is reinvented and reconstructed. Moreover, the epithet scientist-artist evokes ontological concerns. By remodelling the above-mentioned relationship, Panamarenko's man-powered flying machines illustrate the ontological fluctuation between art and science, which call into question the way academic disciplines tend to regard these fields as fundamentally disparate. Hence, I will study not only his theoretical texts and works but also his working method.

Nomad Science and Art

Panamarenko – whose name derives from the acronym standing for Pan American Airlines combined with a fictional Soviet general – was born in Antwerp where he studied at the Royal Academy of Fine Arts between 1955 and 1960. After his graduation, Panamarenko staged happenings in Antwerp before gradually focusing on mechanical constructions. He was one of the driving forces of the Antwerpian neo-

[1] In his quest, Panamarenko seems to work in the tradition of the experimental science of certain fictional characters, such as Alfred Jarry's *Doctor Faustroll* and Pierre Sogol (an inversion of "logos") in René Daumal's *Le Mont Analogue* (1952).

avant-garde in the late 1960s. From 1965 onwards, he became the instigator of various street performances with a group of young artists who occasionally spoofed the city officials and were therefore monitored by the local police. Together with Yoshio Nakajima, Hugo Heyrman and Wout Vercammen, Panamarenko launched a magazine titled *Happening News* (later *Milkyways*), which consisted mainly of visual collages made up of scientific journal articles and American pop culture imagery.[2] The magazine aimed at dissolving the limits of high and low cultural production, and between visual art and technology. An artist by training, Panamarenko's works are by no means limited to the sphere of art or aesthetic design, however. He has always probed the limits of both science and art.

A commonly adopted view amongst critics is that Panamarenko's works take up the playfulness of the 1960s as their point of departure (as did Jan Foncé). Panamarenko's production could indeed be analysed from the aspect of play, for instance by applying Johan Huizinga's (*Homo ludens*) and Roger Caillois's definitions that separate play from the routine of life and thus emphasise its involvement with imagined realities unencumbered by ordinary laws.[3] However, such an approach would dismiss the more

[2] Panamarenko, *Panamarenko Universum*, Antwerp 2014, 10–15.

[3] See: Johan Huizinga, *Homo Ludens. Proeve eener bepaling van het spel-element der cultuur*, Groningen 1938 and Roger Caillois, *Les jeux et les hommes*, Paris 1958. For Huizinga, play is an activity connected with no material interest, and no profit can be gained by it. Furthermore, it sets its own boundaries of time and space. Caillois added some aspects to Huizinga's definition, such as voluntariness, the ontological separation

serious challenge Panamarenko's aesthetics poses to science by negotiating the same discursive space with science. Indeed, these various aesthetic and sociological efforts in analysing Panamarenko's *œuvre* fail to meet the full potential of his theories and works.

Reflecting on science and art as equally important sources of inspiration and means of execution, Panamarenko stated that if "you know beforehand that a thing is going to work, there is no more emotion and all you can do is carry out an existing plan".[4] For him, practical engineering seems to be devoid of imagination and emotional response whereas his imaginative devices provide the opposite (Fig1). In analysing Panamarenko's corpus, the scholar Let Geerling has connoted 'emotion' with "the individual experience of technique as an anthropomorphic aid to increase knowledge of one's own potential and limitations".[5] Such a restricted approach regarding sentiment has, however, a limited means of appreciating the full spectrum of Panamarenko's theories. As engineering is usually considered being devoid of passion, tracing the immediate experience prompted by technology posits Panamarenko's works into the liminal space between science and art.

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from everyday life, uncertainty, unproductivity, distinct rules, and the inclusion of imagined realities.

[4] Cited in Let Geerling, "Exploring Space 'at Very Close Quarters'", in: *Metafor och materia*, Sören Engblom (ed.), Stockholm 1991, 81–88, here 86.

[5] Geerling, "Exploring Space", 86. Geerling anticipates what is today called transhumanism. For a further discussion, see: Max More and Natasha Vita-More (eds), *The Transhumanist Reader*, Chichester 2013.

<IMAGE1>

<CAPTION>A rendering of Panamarenko's 1967 *Vliegtuig* or *Six-Winged Helicopter*, which he realised in full scale.</CAPTION>

Liminal space can be regarded as a kind of melting pot where experimentation is both scientific and aesthetic, thus questioning the duality of science and art. Accordingly:

> A definition of liminality invites or requires the postulation of an open, plural system the constituents of which include a known area A and, at least, a poorly understood area B, plus a recognition of a threshold separating but also relating A and B, the threshold itself having a variable breadth. By 'liminal' we will understand texts or representations generated between two or more discourses, a transition area between two or more universes which thereby shares in two or more poetics.[6]

However, liminal discourses do not merely share varied poetics but rather provide a melange where elements derived from ontologically unambiguous discourses fail to

[6] Manuel Aguirre and Philip Sutton, *Margins and Thresholds: An Enquiry into the Concept of Liminality in Text Studies*, Madrid 2000, 6. The praxis of liminality is akin to Gaston Bachelard's notion of surrationalism, which is the inclusion of an excess of rational thought whereby rational thinking is brought to the limit of the irrational (see: Gaston Bachelard, *La philosophie du non*, Paris 1940). Bachelard's theory had antecessors such as Salomon Friedlaender's anti-Hegelian concept 'creative indifference' (*Schöpferisches Indifferenz*) that dismisses ontological dualities.

establish strict boundaries and adhere to any either/or dichotomy. Moreover, theories are discursive in character and expressed in writing following the conventions specific to scientific sociolects. In liminal space the discourses of science and literature, and their respective sociolects, intertwine.

Studying liminal space calls for an alternative sense of science, because liminal discourses open scientific discourse to the excess beyond it, namely, the literary, and vice versa. Panamarenko's idiosyncratic theories implicitly emphasise their distance from established science and exemplify nomad science. Nomad science was introduced by Deleuze and Guattari in 1980 to reflect the relation of alternative modes of science to established, or "state", science.[7] Nomad science emphasises the fluid and metamorphic character of knowledge, while state science sets and defines the limits of entities, in order to organise component parts into a coherent whole determined by a specific end. Furthermore, whenever the primacy of state science is taken for granted, "nomad

[7] Deleuze and Guattari call it "la science royale", translated as "royal science". However, "state science" is more applicable in the modern day. There are numerous interpretations of the theory: it essentially addresses two phases of science, state science being the finished and rigid phase, with probing nomad phase preceding it. However, these phases necessarily overlap as science develops. In the frame of this essay, I am interested in the theoretical relation between these two kinds of science: state science privileges the fixed over the metamorphic and seeks to establish transhistorical and universally true theories rather than exploring specific, singular instances.

science is portrayed as a prescientific or parascientific or subscientific activity".[8] These attributes reflect the general reception of Panamarenko's theories, such as his "Closed system theory", which scientists have debunked.[9]

Since Panamarenko's constructions appear technological, it should be emphasised that nomad science is not a technology or practice, but "a scientific field in which the problem of these relations is brought out and resolved in an entirely different way than the point of view of [state] science".[10] As such, it is difficult to illustrate the abstract notion of nomad science with practical applications. For Deleuze and Guattari, nomad science addresses first and foremost the internal dynamics of science, but this dynamics also establishes a particular history – the complete array of cases where such a negotiation between nomad and state science has taken place. It is fairly commonplace to categorise that what is not recuperated by state science is art if it lacks obvious practical functionality, as will be exemplified below. Yet, arguably, the distinction is not that clear-cut and exclusive. In Panamarenko's theories the oscillation between science and art is based on liminality rather than a strict categorisation based on functionality. His theoretical writings, like nomad science, continuously cut the contents of state science loose from uncompromising categorisations. Given the anti-essentialist focus of nomad science, it is a concept particularly suitable to the analysis of Panamarenko's

[8] Gilles Deleuze and Félix Guattari, *A Thousand Plateaus*, transl. Brian Massumi, London and New York 2004, 405.

[9] To my knowledge, Deleuze and Guattari did not mention Panamarenko in their works.

[10] Deleuze and Guattari, *Thousand Plateaus*, 405.

experimental physics. However, the emphasis on liminality does not mean that Panamarenko would not have held scientists in high esteem:

> In sciences there is always specialisation and that is why I can speak with a professor or a student and discuss magnetic fields, even if it is outside his specialty, because there is a scientific technique there, enabling one to arrive at a result more quickly and the approaches are also faster.[11]

I propose that in Panamarenko's case, nomad science, exemplified by his theories, is open to the fluidity and metamorphism of art, which is why it sheds light on the liminal and interweaving processes between science and art. Panamarenko's works are not unambiguously art, at least not in the self-assertive sense of *l'art pour l'art*, but rather negotiate the space beyond the strict categories of art thanks to their (at least intentional) functionality. This is to say that there are practical and functional aspects in Panamarenko's works, such as in "Polistes" (1974), a car equipped with jet propulsion where the whole automobile, including the interior, is coated with rubber in order to absorb the frame's vibrations resulting from high speeds.[12] A term such as "nomad art" would exemplify and appropriately counter nomad science, but as the limits of art are less strict than those of science, the benefit of an additional concept would be limited. Suffice to say that Panamarenko's theories come characteristically close to a sense of

[11] Panamarenko, *Berlin, Otterlo, Brussel/Bruxelles 1978-79*, Berlin 1978, 81. All translations are by the author unless otherwise stated.

[12] Panamarenko, *Berlin*, 119. The most obvious failing of the design is aerodynamic: the engine intakes are inefficient and would require a so-called s-duct above the cab.

"nomadic" in that they customarily undermine currently established scientific and artistic categories and (scientifically) conventional methods of execution. While denoting science, he appropriately formulates that "One cannot remain completely enclosed, one cannot make art without drawing its sources from the outside world".[13] Yet, the straightforward conception of the primacy of art as a starting point suggested by the quote is continuously challenged in his theoretical writings.

Panamarenko's *œuvre* pinpoints the nexus of artistic and technological experiment where art reaches towards the scientific and vice versa. He could be termed an artist-engineer akin to Leonardo da Vinci should that figure, in its literal sense, already have not become unusable in the modern world of occupational specialisation. Panamarenko is not a scientist, but neither is he in any traditional sense a full-fledged artist when devising his scientific theories. Raimund Hoghe has pointed this out by stating that "Panamarenko does not mobilise imagination in order to remain in fantasia".[14] His works always reach towards the practical even as if by means of some *ars arcanum*. Such a secret technique or art (note the common Greek origin of the terms in *tékhnē*) hints at a revisitation of the early scientific experiments in the 17th and 18th Century and dismissal of much of modern science. However, in Panamarenko's case the key motif was to gain a personal experience of the process of technological construction following his own theories.

[13] Panamarenko, *Berlin*, 76.

[14] Raimund Hoghe, "Preface: Dreams, Technics, Wings of Nature", in: *The Mechanism of Gravity, Closed System of Speed Alteration*, Panamarenko, Bielefeld 1975, 7–9, here 9.

Experimental Physics and Perpetual Motion

Panamarenko's nomadic theories have the potential – albeit limited due to his status as an artist – to question current scientific principles, and this potential culminates in his experimental physics. He stated that "People have the curious habit of believing that if something has a name it is therefore known".[15] Panamarenko hereby explicitly challenges the complacent trust in science, namely state science, and adopts nomad science by disputing the logic of established science while seeking an alternative. Indeed, state science names things in order to organise knowledge even in cases where the full characteristics of a given phenomenon remain unknown. One such recent instance is the physical anomaly known as hastatic order, which eludes CPT symmetry.[16] Scientists know what occurs in the phenomenon but not the reason for it.

[15] Panamarenko, *For Clever Scholars, Astronomers, and Doctors*, Antwerp 2004, 23.

[16] CPT symmetry is a physical law which states that a phenomenon following the laws of nature is possible even when its local environment is the mirror image of the original, all particles are replaced by antiparticles and time is reversed. For a further discussion on this anomaly, see: Premala Chandra, Piers Coleman and Rebecca Flint, "Hastatic Order in the Heavy-fermion Compound Uru_2Si_2", in: *Nature*, 493, 2013, no. 621, 621–626.

Accordingly, Panamarenko is interested in "gaps in existing physics",[17] which may be anomalies, un- or under-researched areas of interest or phenomena yet to be observed thus not supporting the theoretical postulation of these phenomena – many such examples exist in quantum theory. However, he questions the current limits of science and scientific inquiry: "I think there are aspects of science that have been neglected, which have not been plumbed deeply enough".[18] Thus the field under scrutiny is, explicitly, science. Panamarenko's mistrust in established science seems to be linked with the nomadic forms of art and science, and their eventual dismissal or recuperation by state science.

Panamarenko's working method consists of theoretical research in specialised literature intended for scientists and practical execution that proceeds by means of trial and error. For instance, his "Closed system theory" utilised basic mechanics and electromagnetism with the eventual purpose of ejecting mass into space. The aim was to enable space travel without liquid fuel. Panamarenko theorised that in order to overcome Earth's gravity, the energy required for propulsion would be captured in a closed system.[19] However, some years later he noted that "I found that closed systems do not exist. […] I could have read a schoolbook and known it long ago, but I had to find this out for myself".[20] Such an unscientific, autodidact approach may result in the categorisation of

[17] Panamarenko, "Het rugzakvliegtuig als symbiose tussen verbeelding en machine", in: *Panamarenko*, Wim Van Mulders (ed.), Paris 1989, 3.

[18] Panamarenko, *Berlin*, 81.

[19] Panamarenko, *Universum*, 142.

[20] Panamarenko, *For Clever Scholars, Astronomers, and Doctors*, Antwerp 2004, 21.

nomad science as parascience. Yet, here Panamarenko emphasises the necessity of a personal experience regarding the accumulation of knowledge and its rationale.

In 1975 Panamarenko realised that in addition to the non-existence of closed systems, his theory would not work as it was based on three-dimensional space. He then applied the fourth dimension to his theory, which eventually became the *Toy Model of Space*.[21] The theory revisits Charles Howard Hinton's ideas of non-Euclidean geometry which Hinton introduced in 1880 and which have since been discarded in favor of Einstein's notion of space-time. The fourth dimension became somewhat a commonplace in avant-garde writing and visual art in the 1900s and 1910s for Jarry, Gaston de Pawlowski and Picasso, among others.[22] It is noteworthy that while the scientific appeal of the fourth dimension diminished due to the General theory of relativity, its use became more nomadic. It was still applied in art, because artists did not need to conform to the latest scientific theories. Art indeed enables and even heralds scientific and technical anachronism.

The manifestations of these nomadic forms may seem very much akin to science, as the table of contents to Panamarenko's "Het relativistische interstellaire magnetische ruimteschip" (The Relativistic Interstellar Magnetic Spaceship, 1978) illustrates:

1. History of the principles of propulsion

[21] Panamarenko, *Universum*, 142.

[22] For a further comprehensive discussion, see: Linda Dalrymple Henderson, *The Fourth Dimension and Non-Euclidean Geometry in Modern Art*, Princeton 1983.

2. The classification of magnetic fields
3. A dipole model induces a monopole spaceship
4. Superconduction II and the fixation of the magnetic force
5. The formation of monopoles on type II superconducting metals
6. The monopole's movement along and across magnetic lines
7. Type III perpetuum mobile

Given these topics, it is perhaps unsurprising that Panamarenko took upon himself to design and construct a perpetuum mobile, which could be utilised for transport – a true clean sheet design even though it resembles the archetypical flying saucers of 1950s science fiction (Fig2). According to his theory, space travel would be enabled by utilising forces that already existed in the universe.[23] One such force was electromagnetism, and the closest vast magnetic field was the one surrounding Earth. Panamarenko was interested in the possibility of utilising this field and the force therein as a mode of propulsion. In order to realise the idea, he had to somehow capture the movement of the magnetic field. He wanted to construct a spacecraft using a monopole – that is, a magnet with a single pole – even though scientists claim no such magnet exists.[24] Nevertheless, Panamarenko planned that these magnets would be constructed of type II superconducting materials such as niobium-tin in order to devise a "type III"

[23] Panamarenko, *Universum*, 126.

[24] Panamarenko, *Universum*, 126. Every atom of the periodic table and in the standard model of particle physics lacks a monopole charge, so no ordinary magnet can be made using a monopole. Current interest in monopoles is fueled by superstring theory, which predicts their existence.

perpetual motion machine that rides on a microwave.[25] Even after being dismissed by scientists for opting for anachronistic science and non-existing technology, Panamarenko boasted: "If my theory is correct, it will put the oil sheiks out of business, because I tap the energy directly from the Big Bang…"[26]

<IMAGE2>

<CAPTION>A schematic of Panamarenko's perpetuum mobile spacecraft straddling Earth's magnetic field. The operating principle is explained in the drawing: 1) a superconductive coil made of niobium-tin, 2) a coil of which 1/24 is coated with niobium-tin and the coil only pulls without repelling, 3) a steering coil that is placed outside the field effect of the larger coil. All coils are cooled to four Kelvins. Motion is enabled by the south-aligned fluxons (known as Abrikosov vortices in superconductivity theory) where the supercurrent circulates around a non-superconducting core.</CAPTION>

Panamarenko's lampshade-like machine could not be conceived within the frame of established physics due to the adoption of monopoles. Indeed, this unorthodox tour de force in experimental physics is based on a wildly idiosyncratic idea (being obvious even to someone with a very basic understanding of physics), namely the notion of "light pressure". With this notion Panamarenko discards Einstein's Theory of relativity by dismissing the key formula $E=mc^2$. Instead, he claims, one should adopt the formula

[25] Panamarenko's "Het relativistische interstellaire magnetische ruimteschip", in: *Berlin, Otterlo, Brussel/Bruxelles 1978-79*, Berlin 1978, 8–21, here 20–21.

[26] Panamarenko, *Universum*, 148.

"E=Fmc", which identifies energy with the interdependence of force, mass and the speed of light.[27] In this case neither energy nor mass grow exponentially in relation to the speed of light. Moreover, Panamarenko abandons the idea of space-time in favour of the fourth dimension – outright anachronistically, one might add.

Historical reiterations of this kind were never acknowledged by Deleuze and Guattari to stand for nomad science. Rather, they focused on the dynamics of nomad and state science in the present, regarding how the cumulative "success story" of science was being formed. Panamarenko's determination had little to do with success in a scientific sense. He said that "when I want to build a flying saucer it must also be realised without falsification and if at the last moment it does not work, there is nothing to be done".[28] Here the personal quest is imperative and exemplifies the nomadic character of Panamarenko's theories: success is secondary, it is the quest itself that is significant. This is to say that nowhere does Panamarenko foreground his activities as unilaterally artistic. Even in one of his more recent publications he has not forgone the scientific-technological potential of his creations: "I made a couple [of spaceships] but could not make them rotate (silly enough). It could be that they will not work".[29] The autodidact engineer is not one to discredit himself prematurely.[30]

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[27] Panamarenko, *Clever Scholars*, 78.

[28] Panamarenko, *Berlin*, 77.

[29] Panamarenko, *Clever Scholars*, 25.

[30] His optimism may yet prove not unfounded, even though the perpetual motion machine is unlikely to work. The operating principle of a somewhat similar device is currently being tested by scientists at NASA's "Eagleworks". The so-called EM drive

Man-Powered Flight: Art and Machine

The anachronisms that are abundant in Panamarenko's *œuvre*, such as his purposeful adoption of "obsolete designs", engage the ontological dilemma between art and science which his aeronautical constructions exemplify. Panamarenko was tapping into the transcultural dream of man-powered flight, which is historically perhaps most exemplified by the renowned myth of Icaros.[31] However, from the 1910s to the 1930s man-powered flight was seen as a realistic possibility by many members of the aviation community in Europe.[32] Panamarenko's interest in this mode of flight was kindled by Keith Sherwin's 1971 technical book *Man Powered Flight*, which familiarised him with various experiences of and experiments with single-manned craft.[33] The feasibility of the idea was finally proven in 1988 by the MIT Daedalus airplane, which travelled some 115 kilometres from Crete to Santorini under man-power.

converts electrical energy into microwaves, which provides thrust in space. The drive, however, does not propel matter so it does not follow Newton's third law. Scientists are as of yet unsure of its working principle.

[31] For an overview on the manifestations of early aviation in literature, see: Sami Sjöberg, "L'avion", in: *Petit musée d'histoire littéraire*, Nadja Cohen and Anne Reverseau (ed.), Paris 2015, 55–58.

[32] Jyrki Siukonen, *Uplifted Spirits, Earthbound Machines: Studies on Artists and the Dream of Flight, 1900–1935*, Helsinki 2001, 129.

[33] Panamarenko, *Berlin*, 158.

Yet, Panamarenko was interested in more archaic designs than the MIT plane. Especially in the case of flying machines, an appropriate comparison can be made between Panamarenko and the Russian constructivist Vladimir Tatlin (1885–1953), whose *Letatlin* project resembles Panamarenko's aeronautical constructs and their designs were exhibited together at the Basel Kunsthalle in 1977. *Letatlins* were, in fact, three model airships constructed by Tatlin in the early 1930s. He had felt that contemporary art had become methodologically insufficient and artists required new forms of execution:

> As a result of this work [the Letatlin], I have drawn the conclusion that the artists' approach to technology can and will lend new life to their stagnating methods[.] [...] my apparatus is built on the principle of utilizing living, organic forms. The observation of these forms led me to the conclusion that the most aesthetic forms are the most economic.[34]

Tatlin notably adopted elements from the natural world in his designs. These organic forms were also favoured by Panamarenko who sought to simulate insect flight in his many ornithopters. Ornithopters are aircraft that fly by flapping their wings akin to birds and insects. These designs were somewhat obsolete already when Panamarenko designed his examples, which reveals the evident nostalgic component of his designs.

[34] Vladimir Tatlin, "Letatlin", in: *The Machine: As Seen at the End of the Mechanical Age*, Pontus Hultén (ed.), New York 1968, 145.

Like Tatlin's models, Panamarenko's aeromachines derive from the various designs of the first half of the 20th Century. Indeed, he designed technological prototypes from anachronistic models that were contemporary to Tatlin. However, even though Panamarenko's inspirations seem to derive from earlier examples of human-powered flying, such as Boris Cheranovsky's designs or the numerous *aviettes* common across Europe in the 1920s and 1930s, they do not necessarily follow common physical principles in their design or eventual execution.[35] The physical forms of his machines are often inspired by nature, derived from the observation of birds whereby their similarity with early aeronautical engineering becomes apparent (Fig3).

<IMAGE3>

<CAPTION>Panamarenko doing field tests with his *U-Control III* in Cranfield, England in 1972.</CAPTION>

One of the first experimental planes Panamarenko constructed was the *U-Control III* (1972) – the *U-Control I* existed only as a model and number *II* merely in the form of two drawings. The plane was approximately three metres long with a broad, thirteen metre wingspan, but it seems to have been extremely light (an image depicts Panamarenko holding it in the air with one hand). The wingspan was sizeable, like that

[35] An *aviette* is also called *avion-bicyclette*. Charles Douniol, "Aviette", in: *Le Correspondant*, 1921, no. 284, 358–359. For a further in-depth discussion on these "flying bicycles" and other experimental designs in early aviation, see: Siukonen, *Uplifted Spirits*, especially 121–150.

of a sail plane, in order to generate the necessary lift, with propulsion being produced by two hand-operated cranks along with pedals. The top photo suggests that the vertical stabiliser of the plane functions completely as a rudder, thus simplifying the design. However, the horizontal stabiliser is fixed and may provide some stability to the structure even though additional control surfaces would have been a favourable option. This trade-off means that the design has limited manoeuvring capability should the machine become airborne. However, as is usual with man-powered airplanes, a single human is often incapable of producing enough thrust to overcome drag and generate the required lift. The *U-Control III* could have flown with a combustion-based engine, but that was never the aim.

Based on the design, one can surmise the quality of the flying experience (which Panamarenko undoubtedly imagined). The wing shape is sound but the lightweight structure of the wings, presumably made of balsa wood and plastic foil, does not allow the addition of wingtip landing gear: hence support crew would be required until the plane would become airborne and whenever it was taxiing (see Fig3). Once airborne, the rudder would have enabled only vertical steering (that is, changes in horizontal direction), making the plane uncomfortable and somewhat inefficient. Furthermore, the cranks placed on both sides of the pilot would not allow for adjusting the plane's bank angle by shifting the centre of gravity with body movement. Landing would have also been difficult: the ground effect would have made it almost impossible without diminishing thrust by pedalling slower. An unfixed horizontal stabiliser would have proven useful to facilitate landing, as less thrust also means less control over the airframe.

Panamarenko finalised the plane at the Cranfield Institute of Technology, where he, "as an artist", unsuccessfully sought the help of engineering students with the completion.[36] In other words, Panamarenko wanted to build a functioning airplane and recognised his limited capabilities to pursue this goal single-handedly because his training was not that of an engineer but an artist. Indeed, Panamarenko shared the aspirations Tatlin had regarding man-powered flight some 40 years earlier.

The latter stated that "I count on my apparatus being able to keep a person in the air. I have taken into account the mathematical side, the resistance of the material, the surface of the wings".[37] This suggests that Tatlin was aware of the physics involved in aerodynamic design, such as airflow speeds and the Coandă effect, and optimised the ratio of the frame's lightness and structural strength. The roles of the trained artist and the autodidact engineer intertwined.

However, the artists did not consistently take all the necessary aspects of aircraft design into account, as Panamarenko's *U-Control III* illustrates. In this very sense these designs exemplify nomad science, that is, in their approximative character. Deleuze and Guattari note that nomad science is "anexact [sic] yet rigorous", meaning that it is "essentially and not accidentally inexact". For instance, a circle is an ideal fixed essence whereas roundness is a vague and fluent essence.[38] Hence, nomad science provides an alternative to the categorising efforts of state science, which ultimately require a strict

[36] Panamarenko, *Berlin*, 160.

[37] Quoted in and translated by: Siukonen, *Uplifted Spirits*, 149.

[38] Deleuze and Guattari, *A Thousand Plateaus*, 405.

art/science dichotomy. Jyrki Siukonen has recognised that it "is one of the paradoxes of the twentieth-century Western mind that a failed machine has become known as an outstanding work of art".[39] Indeed, functionality is commonly acknowledged to strip the construct, such as the *U-Control III*, of the status of a work of art – should it have flown.[40] Reciprocally, its non-functionality rendered it an art object that was shown in a gallery a year later. Yet, technology and design may produce highly aesthetic forms, which do not render the design a work of art, as is the case with the Concorde. After the aircraft's withdrawal from commercial service in 2003, it did not unambiguously become a work of art but a part of aviation history.[41] This is to say that a given construction's functionality has a historical dimension (i.e. being once but no longer functional).

In Panamarenko's case any strict demarcation between art and science is difficult, if not impossible, because functionality was his intention – as it was Tatlin's. Their constructs challenge the exactitude required by state science. Yet the demarcation is based on how state science values the construct and what the scientific status of the person designing and constructing the airframe is. Autodidactic approaches to flying have had an

[39] Siukonen, *Uplifted Spirits*, 123.

[40] There are numerous instances of pieces that are both functional machines and kinetic sculptures, such as the constructs of Jean Tinguely, which defy the paradigmatic ontological dichotomy between technology and art.

[41] Even though a Concorde is exhibited at the Paris Charles de Gaulle airport like a ready-made sculpture, most examples are shown in aviation museums and British Airways still maintains one plane in flying condition at the London Heathrow airport.

unfavourable reception, exceedingly so following the development of flight regulations after World War II. As Siukonen aptly notes: "While Tatlin's machine was open to criticism (for being neither the right kind of art nor the right kind of technology), the ornithopter projects in the technological institutes were allowed to continue".[42] It should be emphasised that regarding such constructs as art was not strictly a question of results, that is, the flying capability of the construct. Instead, the official studies persevered because they were part of state science. Accordingly, in the cases of Panamarenko and Tatlin, their training and profession were fundamental factors in the dismissal of their constructions by scientists even before they were tested. Simply put, even if the various 1930s ornithopter designs by scientists did not work, they did not become works of art, because engineers were not as a rule qualified to produce art – at least not in their professional role in the technical institutes. Without doubt the role assumed by the builder (engineer or artist) played a significant part in how these machines were depicted: as novel applications or utopian technologies.

As well as their distinct roles, there is also the liminality of science and art to consider, and their discursive categorisation. Scientists are mainly interested in distinguishing between state and nomad science whereas the ontological dilemma of art versus science is often left to art historians. An art historian is unlikely the one to proclaim that a construct is scientific in character. By their liminality, Panamarenko's constructions make this institutional process visible and remind that art history is included in state science along with all established fields of study.

[42] Siukonen, *Uplifted Spirits*, 131.

A further aspect worth considering is that if Panamarenko would have succeeded in building a plane capable of flying, would his artistic sensibility have received appraisal together with his autodidact engineering skills. Here the problem between art and science culminates in the difference between a model and a metaphor. For instance, the poet and inventor Charles Cros (1842–1888) was among the first to invent the phonograph (he called it a *paléographe*) in 1877 – Thomas Edison got there first, but not by far. We may surmise that Cros the scientist built the device and was credited for it, but who originally came up with the idea: the scientist or the poet?[43] The model is the executed construct of the idea, but the origin of the idea may indeed have been metaphorical and devised by poetic imagination.[44] Such an approach is not as plausible in the case of Panamarenko's aeronautical constructs (that revisit archaic designs) as it is in his theories regarding space travel. Does the idea of straddling the Earth's magnetic field not sound poetic, like a metaphorical idea preceding the lengthy study of specialised technical literature and the devising of any model? Panamarenko shed no light on the origin of his ideas; neither do scientists necessarily, for that matter.

Scientific-Artistic Imagination

[43] I am grateful to docent Timo Kaitaro for directing my attention to the potential interplay of model and metaphor in Cros's thinking.

[44] Fernand Hallyn has examined the similarity between the scientific and poetic imagination in his book *The Poetic Structure of the World: Copernicus and Kepler* (1990).

Panamarenko's theories give rise to the liminal space between art and science and illustrate how the discourses in this field are affected by state science. This space tends to be defined by art and literary historians who seldom have the necessary expertise in physics, mathematics and materials science (the author included). In Panamarenko's case, the nomadic character of his theories reinforces an open-ended vision of science, which is not comprehensively distinguishable from theoretical and technological artistic endeavours. He appears to have tested the limits of science rather than merely seeking to emulate it.

Panamarenko retired in 2005 at the age of 65. As he no longer occupies himself with various constructions, it remains unknown what he could have achieved with contemporary materials, such as the composites that are currently commonplace in aircraft design. However, such materials would require industrial production unlike balsa wood and plastic, which allow the artist to execute his designs single-handedly. 3D printing has also opened new possibilities regarding both technology and materials, but that would perhaps be too modern for Panamarenko's liking, as he steered clear of computers. The defining characteristics of his *œuvre* are technical anachronism and the avant-gardist subversion of the generally accepted limits of science.